



Provenance analysis of Devonian to Permian island arc systems and of a Lower Cretaceous collapse basin of easternmost Altaids, NE China: a contribution to the origin of accretionary orogens

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The focus of the paper lies upon provenance analysis of sandstones collected from Ordovician to Permian island arc systems in NE China (provinces Jilin, Heilongjiang, Inner Mongolia) exposed to the east and west edge of the Mesozoic-Cenozoic Songliao basin and of a Lower Cretaceous molasse basin on the top of the Jiamusi block. The main goal of this study was the proof of stepwise accretion and subsequent transformation of island arc systems to a craton, deduced from these Ordovician to Permian island arc and Lower Cretaceous collapse basin-type siliciclastic sedimentary units. Northeast China is considered to be part of the Altiid orogenic systems, an accumulation of Paleozoic island arcs surrounded by Precambrian microcontinents. The aim of this work was to characterise the geodynamic evolution of the easternmost Altaids from island arcs to its consolidation during Mesozoic times with samples from different stratigraphic levels. The stratigraphic age of investigated mud- and sandstones varies from uncertain Ordovician to Devonian–Permian and Lower Cretaceous. The samples were processed with three methods, namely chemistry of shales, modal analysis of sandstones and $40\text{Ar}/39\text{Ar}$ age dating of rare white mica grains extracted from sandstones.

All results show a significant difference between Paleozoic (Devonian, Carboniferous and Permian) samples and Lower Cretaceous ones. The Paleozoic sandstones show mostly greywacke composition and contain rare white mica. All $40\text{Ar}/39\text{Ar}$ ages from mica grains measured from Paleozoic sandstones comprise mostly a cluster at ca. 500 Ma. Permian samples also contain an additional cluster at ca. 380 Ma, and the youngest ages are at 221.3 ± 1.3 Ma and 278.4 ± 2.5 Ma. In contrast, the Lower Cretaceous sandstones are mostly arkoses. One group of samples show a Lower Jurassic age cluster centering at 189 Ma, and a smaller one at ca. 500 Ma, the latter similar to the Paleozoic samples. The other group of Lower Cretaceous samples is entirely different with a relatively uniform spread of ages between 113 Ma and 233 Ma, some ages are partly quite close to the stratigraphic/depositional age and overlap with it. The depositional age indicates exhumation of a Cretaceous-aged metamorphic complex likely in extensional tectonic regime.

All the new data corroborate the hypothesis of Paleozoic accretionary orogens, which changed from island arc accretion to collision forming continental crust during Permian times, which underwent extension in Mid to Late Mesozoic times.